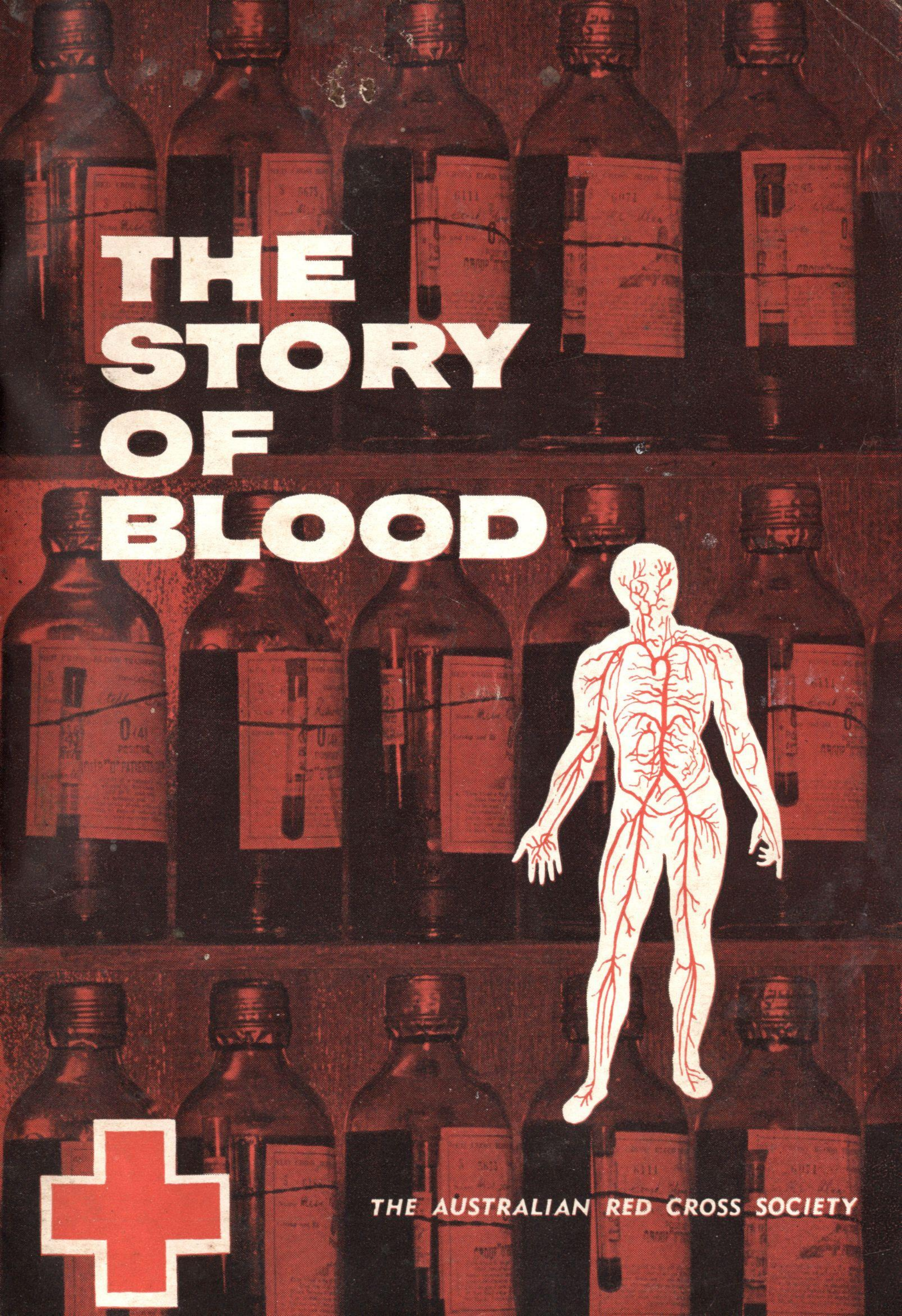

THE STORY OF BLOOD

THE AUSTRALIAN RED CROSS SOCIETY

DO YOU KNOW?

Every pint of blood distributed by the Red Cross in Australia is the free gift of a voluntary donor. The Red Cross supplies it to patients without charge.

Any healthy person between 18 and 60 years of age can be a blood donor.

Giving is painless. It does not affect the health.

YOUR blood is needed to save lives. Become a blood donor today.

RED CROSS NEEDS MORE DONORS

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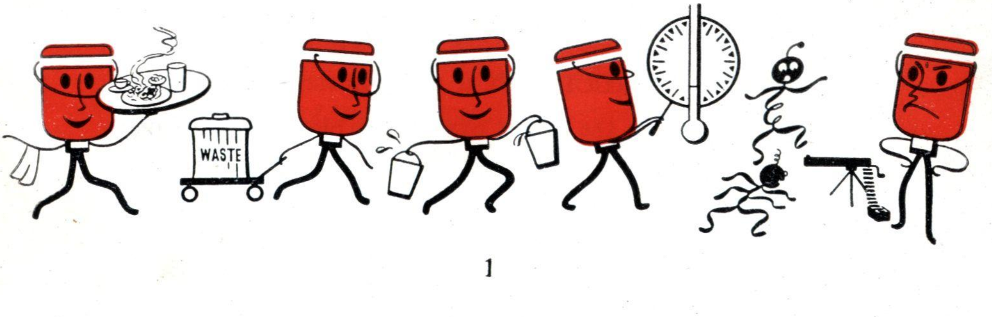
8th EDITION
(Reprint 1/6/61)

THE STORY OF BLOOD

1. WHAT IS BLOOD?

Blood is a living tissue, and its function is to carry nourishment to all the other tissues of the body. When there is not enough blood, or when its circulation stops, the tissues involved die of starvation. To help protect it against loss of blood, the body is capable of producing enormous quantities of fresh blood as required, and in fact old blood is being replaced by new all the time. The reserve capacity is such that there is far more than any person could expect to need in a lifetime. This is why it is quite safe to give so much away in regular donations. People need transfusions when they lose so much blood that their bodies cannot produce fresh supplies quickly enough. A transfusion of someone else's blood will then tide them over until their own body can catch up.

The importance of blood is no new discovery; the first caveman who saw a man, or animal, bleed to death must have realised that we cannot live without it. So through the ages blood became endowed with wonderful and magical properties, till it was thought to be the essence of life itself. Nowadays we know a good deal about the composition and functions of the blood, and our ideas are less fanciful. But it is still true that we cannot do without blood. There is no substitute for it. Those who have lost much blood will die if it is not replaced, and it is only since 1900 that we have been able to do this safely by transfusion.



In this booklet we try to give a few facts about this remarkable fluid. To be at all exhaustive would need a large book, and many have been written. Our aim here is only to give the ordinary person some very rough idea of the wonderful complexity of the blood that is coursing round inside him, and which, as a blood donor, he can give to help his fellow-men.

WHAT DOES BLOOD DO?

Blood, which the heart pumps rapidly round and round the body through miles of blood vessels, does many things to keep us alive and healthy. It carries the necessities of life—oxygen, water and food—to all the cells of the body.

Blood helps the cells of the body to breathe by bringing them oxygen from the lungs and by taking carbon dioxide from the cells back to the lungs, where it is expelled.

It carries food from the intestines to the cells and carries waste products to places where they are removed from the body. It also furnishes water to the cell tissues.

It distributes heat produced by the working muscles; blood serves as a temperature regulator for the body.

In addition to all these jobs, blood, by the action of its white cells, antibodies and certain complex chemical substances, serves as a constant bodyguard against infections and other diseases.

Blood does these things for us in its normal course through our bodies. In addition, as we shall see later, our donations of this magic fluid may help to save the lives of others.

There is no such thing as a substitute for blood.

HOW DOES IT CIRCULATE?

The heart pumps the newly oxygenated blood through the arteries to the tiny capillary vessels in all the tissues of the body. Here the blood gives up oxygen and food and collects waste products. It returns by the veins to the heart, which then

sends it to the lungs to collect fresh oxygen and lose carbon dioxide. From the lungs it goes to the left side of the heart and the cycle begins again.

WHAT IS IT COMPOSED OF?

Blood appears to be a red liquid. But if blood that has been prevented from clotting is allowed to stand, we find that it separates into two layers. At the top there is a clear pale yellow fluid—the plasma—and beneath this there is an opaque deep red layer. If we examine this red layer with a microscope, we find that it is made up of separate tiny living disc-shaped corpuscles or cells, and smaller bodies called platelets. Some of the corpuscles are red, and give the blood its colour; others are white.

Blood then is not a red liquid; it is a living tissue composed of pale yellow liquid—the plasma—with corpuscles (mostly red) floating in it. The corpuscles or cells make up nearly half the volume of the blood.

WHAT ARE THE RED CELLS?

The red corpuscles of adults are made in the marrow cavities of certain bones, especially the spine, ribs and breastbone. These cells are disc-shaped, and thicker at the edges than in the middle. 3500 red cells placed edge to edge would measure about one inch, and an average man has about twenty-seven million million (27,000,000,000,000) of them in his blood. All the red cells from one man placed edge to edge would reach about 120,000 miles, or five times round the earth.

At a certain point in the development of the red cell, a substance named haemoglobin is deposited in it. This haemoglobin consists of the iron-containing red pigment (haem) combined with a protein substance (globin). It is the haemoglobin which gives the red cells their colour and also their ability to pick up oxygen in the lungs.

Iron is a key raw material required by the red cell factories. Part of this is "scrap iron" salvaged from broken-down red cells; the rest comes from food. It is necessary to have enough iron in the body to keep the production of haemoglobin up to the normal rate. The average person has about 1/6 of an ounce in his body—that is enough to make two 2-inch nails. If iron is lacking, the amount of haemoglobin in the red cells is lowered, and later the number of red cells in the blood is reduced. The best food sources of iron are meat (especially liver), eggs, whole-meal bread, and green vegetables.

Within the body, red cells have been found to live about 100 to 120 days, but some cells last as long as 140 days. The rugged conditions under which the fragile red cell lives are the reason for its short life span. This delicate structure has to withstand constant knocking about as it is pumped into the arteries by the heart. Travelling through blood vessels at high speeds, bumping into other cells, bouncing off the walls of the arteries and veins, squeezing through narrow passages and adjusting to continued changes in pressure, all tend to wear out the red cell. As it gets older, its resistance to such abuse is reduced, and the cell breaks into pieces. Fragments of red cells, some only dust-like particles, are found in the blood, the spleen

and sometimes in other body tissues. Old or dead cells are removed from the blood by the spleen, which in this capacity is considered a "graveyard."

Red cells provide the body with a motor transportation system for gases. After picking up oxygen in the lungs, red cells deliver it to the tissues, where it is used. Ordinarily, only one-fifth to one-fourth of the oxygen load is released, as the tissues are not able to absorb more than they need at the moment. The rest of the oxygen remains in the haemoglobin as an emergency reserve supply. When fully charged with oxygen, blood is bright cherry-red in colour; when de-oxygenated it is dark, bluish-red.

White Cells

Research has shown that white cells are probably made in the bone marrow and in certain lymphoid tissues of the body. There is only one white cell to every 600 red cells. These white cells are among the most important agents by which the body defends itself against disease. Their ability to move and to engulf solid particles permits them to meet and attack invading bacteria. They act like mobile patrols, and can reach almost any part of the body by squeezing through crevices in the walls of the capillaries (the smallest blood vessels). White cells are able to move out of a blood vessel, and great numbers of cells can, in this way, leave the blood in a short span of time and reach the place of injury or infection.

White cells can be thought of as a defending army, with various corps having their own specialties. When the body is attacked by an invading disease, the white cells close in. One group, the neutrophils, "fights" the bacteria by "eating" them. As many as 20 or more bacteria have been found inside one attacking white cell. Another group, the lymphocytes, discharge anti-toxins that poison the invading bacteria; other anti-toxins remain for a while to protect the body from a counter-attack.

There are times when the existing white cells are inadequate to hold back the progress of the disease, and additional forces are needed. When the cell-forming organs of the body get the "alarm" from those white cells already fighting, the emergency is met by releasing available reserves into the blood. If the condition is critical, even very young cells can also be released as a last resort to help fight the disease.

Platelets

Platelets are probably made in the giant cells of the red bone marrow. There are about one and one-half trillion platelets in the normal average body, and after a short life of only three or four days they are removed from the blood by the spleen, lymph nodes and liver.

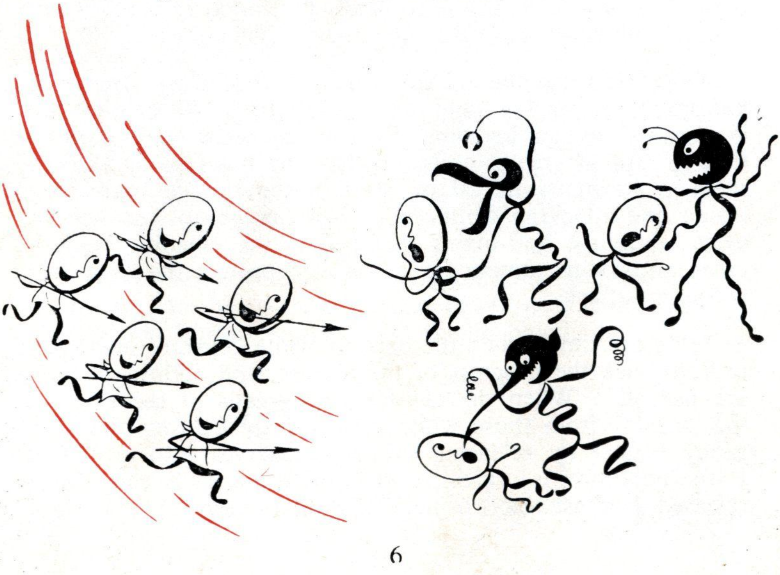
Platelets control bleeding by blocking small holes in blood vessels and, by assisting in blood coagulation, help produce the clot which plugs up larger holes.

Plasma

Plasma is composed of water (about 91-92 per cent.), proteins (about 7 per cent.), and very small amounts of fats, sugar and mineral salts. The sticky or gummy quality of blood that is necessary for maintaining normal blood pressure is partly caused by the plasma proteins. Without certain proteins blood would not clot, and it is by clotting that bleeding is stopped.

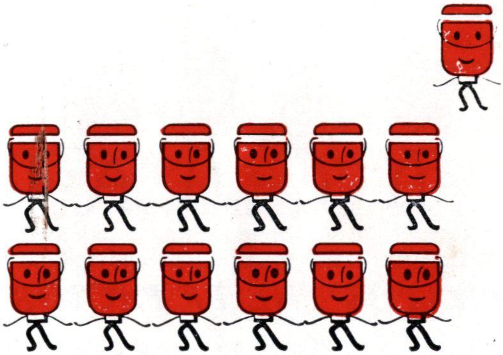
Co-operation

Although the parts of blood have been discussed separately, the work of all parts is carried on simultaneously and in a co-ordinated manner. For example, at the same time that white cells are attacking injurious bacteria, the antibodies of the plasma proteins are also helping to protect the body by counteracting the effects of the invaders.



HOW MUCH BLOOD HAVE YOU?

The normal human adult has approximately 1 pint of blood in his body for every stone weight.



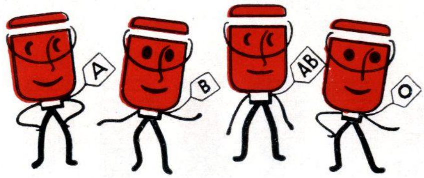
Under certain conditions, when the supply of oxygen to the tissue is low, the blood volume may be increased. These conditions include exposure to high temperature, high altitude, muscular exercise, emotional excitement and pregnancy. A reduction in blood volume below its normal level may be caused by haemorrhage, a decrease in the total number of red cells, the loss of plasma caused by extensive burns, or the loss of water from the blood.

WHAT IS YOUR BLOOD GROUP?

There are four main types of blood, called A, B, AB, and O. In addition, sub-groups of these main groups have been found. Every human being belongs to one or other of these groups.

When a person requires transfusion of whole blood, he must have blood which matches his group. Therefore, type A blood is given to group A patients, type B blood to group B patients, and so forth. Giving type A blood to a type B patient causes the cells to clump, often with fatal results; however, under certain conditions, type O blood may be given to group A, B, or AB patients.

To make sure that the blood to be given to a patient "agrees" with his blood, samples of each are first cross-matched. If the cells from the donor's sample do not clump when added to the blood serum of the patient's sample, the bloods are "compatible," and successful transfusion is possible.



WHAT IS THE Rh FACTOR?

The Rh factor is an additional blood type which was discovered in 1940. Blood Banks now store blood in eight different categories, viz., O positive, O negative, A positive, A negative and so on. The discovery of the Rh factor explained at last many of the severe and even fatal reactions which sometimes followed a blood transfusion, even though the major groups tallied correctly. Moreover, doctors were frequently at a loss to explain numbers of stillbirths and the often fatal jaundice developing in new-born infants. It was noted, however, that these tragedies most frequently occurred when the mothers had had difficulty in previous confinements or had received a blood transfusion. It is now known that this condition also is due to incompatibility involving the Rh factor. This factor received its name because it was first recognised in Rhesus monkeys, and the 85 per cent. of the human white race who have this blood characteristic are called "Rh positive" and the remaining 15 per cent. who lack it, "Rh negative." The Rh positiveness or negativeness of any individual is determined by inheritance in the same way as colour of the skin, eyes, hair, etc., and does not change throughout life.

The Rh factor is of importance in transfusion and in pregnancy, because the entry of Rh positive blood into the circulation of Rh negative persons may cause the production of antibodies in the same way as a diphtheria vaccine produces antibodies against diphtheria. When this occurs, we say that the Rh negative person has been "sensitised to the Rh factor."

Although these anti-bodies are actually a defence against foreign material and cause no reaction of themselves in the sensitised person, we shall see that their presence is a potential danger.

There are two ways by which Rh sensitisation may be brought about.

First, by transfusion of an Rh negative person with Rh positive blood; a large proportion of such persons will become sensitised, and produce antibodies. A subsequent transfusion of Rh positive blood may result in a serious, if not fatal, transfusion reaction as the Rh positive cells meet the Rh antibodies and are destroyed.

Second, by pregnancy. Fortunately, this does not happen in all cases but in only approximately one of every one hundred and fifty pregnancies, and very rarely in a woman's first pregnancy. The marriage of an Rh negative woman to an Rh positive man may result in an Rh positive child. Before birth, the infant's Rh positive red blood cells may enter the mother's circulation, causing her to be sensitised. The antibodies thus formed in the mother then return to the infant and cause destruction of its blood cells. This will result in anaemia, jaundice or even still-birth.

It is important that all pregnant women be tested to determine whether or not there may be impending damage to the infant, so that appropriate measures may be taken. In these days, the hazards of the Rh factor may be reduced to a minimum by transfusion of the newborn child.

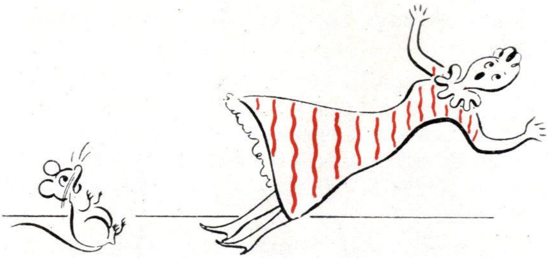
WHAT OTHER BLOOD GROUPS ARE THERE?

We have already mentioned the ABO and Rh blood groups. There are many others, such as the MN, P, Kell, Duffy and Lewis groups; some of these are named after the people in whose blood they were first discovered. They are of less practical importance than the ABO and Rh groups.

HOW DO WE DETERMINE BLOOD GROUPS?

We test for blood groups in the laboratory by using samples of serum which contain particular antibodies. (Serum is the same as plasma, but derived from blood that has clotted.) When serum containing a particular antibody is added to red cells of the appropriate kind, they are agglutinated. We carry out these tests on tiles or slides and the agglutination is quite obvious to the eye. Laboratories have many different kinds of serum; for example, an anti-A serum detects red cells of group A, and an anti-Rh serum agglutinates Rh positive cells.

WHAT IS SHOCK?



Shock is the body's reaction to injury. In mild shock resulting from slight wounds or surgical operations, the effects on the circulation do not last very long, and usually no treatment other than rest is necessary.

In severe shock, in which there is a marked loss of blood volume, the effects on the body are serious and complex. The loss of fluid begins when damage to the tiny blood vessels around the injury allows plasma and some blood cells to escape into the tissues. Less blood is then returned to the heart, and hence less blood is delivered to the spleen, liver and outer parts of the body. Circulation is slowed, thus causing a radical drop in the amount of oxygen delivered to the tissues. The less oxygen the tissues get the more fluid leaks out of the blood vessels and the viscosity of the blood increases, causing further slowing of the circulation. Thus starts a vicious cycle which is difficult to stop without a blood transfusion. After shock reaches a certain stage the brain, too, is affected, and the process cannot be reversed.

If the lost blood volume is quickly replaced, the tissues will not lack needed oxygen and the serious shock cycle will not begin. The physician can tell the state of the shock cycle by blood pressure and pulse reading and also the general appearance of the patient. His cold white skin, restlessness and thirst indicate that shock is impending or is in progress.

FORMS IN WHICH BLOOD IS USED

Whole Blood.—The term "whole blood" is used here to denote fresh blood to which a preservative has been added. This preservative is usually a solution containing citric acid, sodium citrate and dextrose—an ACD solution. Whole blood must be stored in refrigerators at a temperature of from 4 to 6 degrees Centigrade; under these conditions it may be kept for about 21 days.

Whole blood transfusions are necessary whenever large amounts of blood have been lost as a result of an accident, injury, childbirth, or certain diseases. Whole blood may also be used for the treatment of haemorrhage diseases and chronic anaemia.

Packed Cells.—Many transfusions are given only for the sake of the red blood cells. In these cases the cells can be separated from the plasma in a centrifuge and transfused in a concentrated form, while the plasma can be used for other purposes.

Plasma.—Plasma, the liquid portion of blood, is separated from the red cells as above or by means of a milk separator. The heavier, cellular elements of the blood come out by the milk outlet, whilst the lighter plasma is collected from the cream outlet. The plasma is then fractionated or else is clotted to convert it to serum, and the serum is filtered to remove any bacteria that may have entered during the process, and is then bottled ready for use.

Serum is sometimes used in the treatment of burns to replace the fluid lost from the blood.

Fractions.—Plasma has been broken down into fractions by a process known as "selective precipitation." As a result of mixing plasma with certain chemicals, the individual protein constituents can be separated one after another in the form of pastes. These pastes are quickly frozen, then dried. The proteins appear as dry white powders, and in this form are

stable and easily stored. Later they are dissolved, sterilised and packaged.

Many fractions have been isolated, and from these several derivatives are now available for medical use; as research continues, more will be available.

This complicated and highly technical process is now in operation at the Commonwealth Serum Laboratories in Melbourne. Albumin, Gamma Globulin and Fibrinogen are in full production, and small quantities of less important fractions are being obtained.

Serum albumin has about half the protein content of plasma. It is used in the treatment of certain kidney and liver diseases and for the emergency replacement of lost blood volume.

Because it is easy to store and administer, it is used for emergency cases, such as accident victims and in remote areas, where facilities for administering whole blood are not available. Because it does not contain any blood cells, serum albumin does not belong to any particular blood group, and can be given to anybody without previous testing.

Immune Serum Globulin is used for the modification or prevention of certain infectious diseases such as German measles, infective hepatitis, mumps and measles. Measles, although a common childhood disease, is sometimes dangerous in that it may sometimes result in complications such as injury to the eyes, ears, lungs and heart.

Antihaemophilic Globulin is used to control bleeding when it is the result of haemophilia. By injecting the patient with this globulin, the abnormal time required for the clotting of his blood is temporarily reduced.

Fibrinogen.—This is the protein which actually forms blood clots. In some conditions associated with childbirth, haemorrhage, or incompatible blood transfusion, the patient's blood may become unclottable, and the administration of this substance is life-saving.

Thrombin is a substance which reacts with fibrinogen in the clotting process. By combining them **Fibrin Film** and **Fibrin Foam** are produced. Fibrin film is a cellophane-like sheet which can be used to repair tissues in brain and nerve surgery. Fibrin foam is a spongelike product used to stop bleeding from surgical or accidental wounds.

WHY SHOULD I BECOME A BLOOD DONOR?

The Red Cross Blood Transfusion Service depends entirely on its voluntary donors. They receive no tangible reward. But when blood is wanted the need is often desperate, and by giving your blood you can help to save lives. In these days few people will get the opportunity for acts of dramatic heroism, but almost everyone can be a blood donor. Our donor panels in Australia are only just big enough to meet the daily needs of the hospitals. In any sort of emergency, and especially in a nuclear war, we would need far more blood than we can get now. Help us to be ready.

WHAT WILL IT INVOLVE?

No more than once in three months, you will be asked to give blood if you can. You are free to refuse any call if you wish. At the transfusion centre or mobile unit, this is what will happen. When you arrive a tiny drop of blood will be taken from your finger or ear lobe and tested to see that you are not anaemic. If the test is satisfactory you will lie on a couch and a pneumatic bandage will be wrapped round your upper arm. With a very small needle an injection of local anaesthetic will be given at the bend of the elbow; this deadens the skin. Then a needle with a tube attached will be inserted into a vein; this is completely painless. The blood will run in: a bottle, out of sight, in five minutes or so. When the donation is complete the needle will be removed, and you will rest for a while before going to another room for refreshments. That is all there is to giving blood. It is almost painless, not at all unpleasant, and no healthy person is any the worse for it.

You will find the telephone number of your Blood Centre on the back page of this booklet. Phone today to make an appointment.

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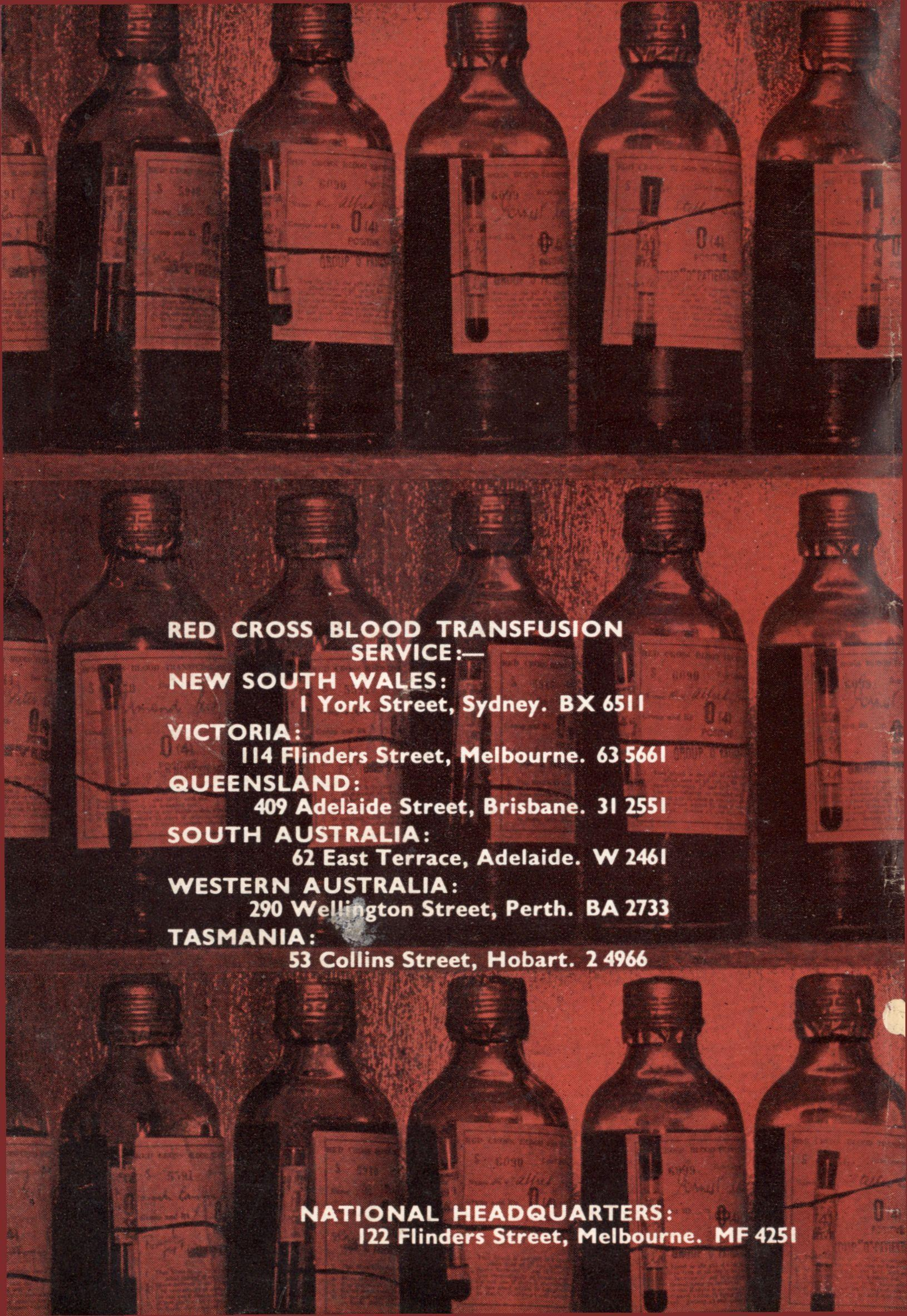

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